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EVALUATING THE ENACTMENT OF TEACHER DIGITAL COMPETENCE: A CONVERGENT MIXED-METHODS APPROACH

Nidal Abounajem — Sharjah Education Academy, Sharjah, United Arab Emirates — nidalabounajem@gmail.com

ABSTRACT

Aim/Purpose	This study examines the relationship between teachers' self-reported digital competence and its enactment in classroom practice, addressing limitations in how education systems evaluate the patterns of ICT integration.
Background	While frameworks such as Technological Pedagogical Content Knowledge (TPACK) and DigCompEdu have conceptualized teacher digital competence, less is known about how self-reported competence aligns with observable classroom enactment.
Methodology	A convergent mixed-methods design was employed, combining pre–post self-reported competence surveys with structured classroom observations. The sample comprised 150 teachers across nine private schools in the United Arab Emirates (three schools per emirate: Abu Dhabi, Dubai, and Sharjah), selected using a purposive, multi-stage sampling strategy. Classroom observations were conducted with a randomly selected subsample of 55 teachers drawn from the participating cohort.
Contribution	This study contributes to the literature by (1) reframing digital competence as an enacted pedagogical construct, (2) providing empirical validation of the degree of alignment between self-reported and enacted competence, and (3) advancing a methodological approach that integrates perception-based and observational data to provide a more comprehensive evaluation of enacted digital competence.
Findings	Results indicated a statistically significant increase in self-reported digital competence from pre-intervention ($M = 1.85$, $SD = 0.83$) to post-intervention ($M = 3.19$, $SD = 0.93$), $t(149) = 18.62$, $p < .001$, Cohen's $d = 1.52$. The proportion of teachers at the Intermediate stage or above increased from 20.0% (n =

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	30) to 78.7% (n = 118). Classroom observations documented instructional ICT practices that were broadly consistent with teachers' reported post-intervention competence levels, with 65.5% alignment between perceived competence and documented classroom practice.
Recommendations for Practitioners	The findings suggest that school leaders should adopt structured frameworks that align digital competence with classroom practice to guide professional learning, instructional coaching, and monitoring of ICT integration.
Recommendations for Researchers	Future research should incorporate longitudinal designs, multiple observers to enhance reliability, and cross-context comparisons to examine further the relationship between perceived and enacted digital competence.
Impact on Society	By strengthening the alignment between digital competence frameworks and classroom practice, this study supports more effective implementation of technology in education systems that may be associated with improved teaching quality and student learning outcomes.
Future Research	Further research should explore scalability across different education systems, investigate subject-specific applications of digital competence, and examine the long-term sustainability of competence enactment following professional development interventions.

Keywords	teacher digital competence, ICT integration, classroom observation, mixed methods

INTRODUCTION

The integration of information and communication technologies (ICT) into classroom practice has become a central priority in education systems worldwide. Policy agendas increasingly position teacher digital competence as essential for enhancing teaching quality and student learning outcomes (OECD, 2019; Redecker, 2017). Substantial investment in digital infrastructure has followed, premised on the assumption that access to technology will translate into pedagogical innovation. However, empirical research consistently indicates that access alone does not produce instructional practices associated with higher levels of ICT integration (Fullan, 2020).

A persistent tension, therefore, exists between digital policy ambition and classroom enactment. Studies suggest that teachers' ICT use often remains at a substitutional level, characterised by presentation, content delivery, and administrative functions rather than pedagogically purposeful integration (Ertmer & Ottenbreit-Leftwich, 2010). While digital competence frameworks acknowledge the importance of pedagogical understanding and professional judgement (Mishra & Koehler, 2006; Redecker, 2017), translating these into observable instructional behaviour has proven challenging in practice.

Several international models have been developed to conceptualise teacher digital competence, including DigCompEdu, the Technological Pedagogical Content Knowledge (TPACK) framework, and the ISTE Standards for Educators (Mishra & Koehler, 2006; Redecker, 2017). These frameworks provide a robust theoretical articulation of the knowledge domains underpinning effective ICT integration. However, empirical evaluation frequently relies on self-report instruments, with comparatively fewer investigations examining the extent to which reported competence development corresponds with observable pedagogical enactment (Horváth et al., 2025; Kadluba et al., 2025). This creates an important methodological challenge: increases in reported digital competence do not necessarily correspond to observable pedagogical practice. Although recent studies have begun examining this relationship (Horváth et al., 2025; Kadluba et al., 2025), less is known about the extent to which

self-reported competence aligns with enacted classroom behaviour across different educational contexts.

This study addresses a specific empirical and methodological challenge within digital competence research. While existing frameworks extensively conceptualise teacher digital competence and its constituent knowledge domains, fewer studies have examined the extent to which self-reported competence aligns with observable classroom practice. Moreover, many existing studies continue to rely predominantly on perception-based measures, with limited integration of structured classroom observation to examine enacted instructional behaviour. This study directly addresses this gap by systematically examining the alignment between self-reported digital competence and observed classroom practice using a convergent mixed-methods design. This limitation has significant implications for policy and practice, as education systems investing heavily in digital transformation have limited mechanisms for determining whether teacher competence is reflected in observable classroom practice.

The challenge, therefore, is not only conceptualising digital competence but also operationalising it in ways that capture enacted instructional practice. Without structured mechanisms to examine how technology is used pedagogically, competence frameworks risk functioning as abstract descriptors rather than as evaluative tools capable of monitoring classroom-level transformation. This study advances the field by reframing digital competence as an enacted pedagogical construct—defined not by declarative knowledge or tool familiarity, but by observable instructional behaviours aligned with learning intent. In doing so, it shifts the evaluative focus from perceived capability to demonstrable practice. It introduces a methodological approach for examining the degree of alignment between self-reported competence and classroom enactment.

Within the United Arab Emirates (UAE), digital transformation has been positioned as a national priority, with the Knowledge and Human Development Authority, the regulatory body responsible for overseeing private education quality in Dubai, applying the UAE School Inspection Framework, which emphasises innovation and effective ICT integration in teaching and learning (Knowledge and Human Development Authority [KHDA], 2015). Despite high levels of technological resourcing, variability in ICT integration practices remains evident across educational systems internationally, suggesting that access alone does not necessarily result in pedagogically meaningful technology use (Tondeur et al., 2016). This context reinforces the need for practice-oriented, context-responsive models capable of linking professional development to observable instructional enactment.

To address the persistent gap between self-reported competence and observable classroom practice, the present study reports on the development and empirical examination of a staged, practice-oriented Teacher Digital Competency Framework (TDCF). Unlike models that risk functioning as knowledge-based or tool-focused descriptors, the TDCF foregrounds observable pedagogical behaviours aligned with instructional purpose. The framework was implemented alongside targeted professional development, and its outcomes were examined using a convergent mixed-methods design that combined pre- and post-intervention survey data with structured classroom observation data.

The study is guided by the following research questions:

RQ1: To what extent does participation in a staged, practice-oriented digital competence framework influence teachers' self-reported digital competence?

RQ2: To what extent is reported digital competence development reflected in observable classroom ICT practices?

RQ3: What patterns of convergence or divergence emerge between self-reported competence measures and structured classroom observation data?

By aligning perception-based measures with classroom-level evidence, this study contributes to the methodology by offering a replicable evaluation model for examining enacted digital competence. Conceptually, it extends digital competence scholarship by shifting analysis from knowledge-based

articulation to observable pedagogical enactment. While situated within the UAE context, the staged design and analytic logic offer transferable insights for systems seeking to strengthen the alignment between digital competence frameworks, professional learning, and instructional practice. The remainder of this paper is structured as follows. The next section synthesises the literature and identifies the analytical gap that the study addresses. The research design, framework development, instruments, and analytic procedures are then presented, followed by the quantitative and observational findings. The final section integrates findings with existing research and articulates theoretical and practical implications.

LITERATURE REVIEW

TEACHER DIGITAL COMPETENCE AND ICT INTEGRATION

Teachers' digital competence has been widely recognised as a key determinant of effective ICT integration in classrooms. Research consistently demonstrates that meaningful technology use depends more on teachers' pedagogical beliefs, instructional clarity, and professional judgement than on access to hardware alone (Ertmer & Ottenbreit-Leftwich, 2010). Teachers who lack pedagogical alignment when integrating ICT are more likely to replicate traditional practices digitally rather than transform learning experiences.

Digital competence is increasingly conceptualised as a multidimensional construct encompassing technical, pedagogical, and professional domains (Mishra & Koehler, 2006; Redecker, 2017). Effective ICT integration requires alignment between digital tools, curriculum objectives, learner needs, and assessment practices. However, research indicates that teachers often struggle to operationalise these dimensions in practice, particularly when professional development prioritises tool functionality over instructional application (Fullan, 2020). This tension highlights a critical distinction between competence as knowledge and competence as enacted pedagogical behaviour.

INTERNATIONAL DIGITAL COMPETENCE FRAMEWORKS

Several international frameworks have been developed to guide the development of teachers' digital competence. The TPACK framework conceptualises effective ICT integration as the intersection of technological, pedagogical, and content knowledge (Mishra & Koehler, 2006). DigCompEdu extends this articulation by specifying competence areas and progression descriptors across professional engagement, pedagogy, assessment, and learner empowerment (Horváth et al., 2025; Redecker, 2017). Similarly, the ISTE Standards provide aspirational indicators of effective technology-enhanced teaching practice.

While these frameworks offer robust conceptual guidance, their classroom-level operationalisation has proven uneven. Teachers frequently report difficulty translating abstract descriptors into observable instructional decisions, and school leaders face challenges in using such models to monitor practice or design targeted professional development (Fullan, 2020). Moreover, empirical studies evaluating digital competence frequently rely on perception-based survey instruments, with limited triangulation through structured classroom observation (Tondeur et al., 2016, 2017). This methodological tendency risks conflating perceived competence with enacted practice and raises questions regarding the construct validity of digital competence measurement.

The literature, therefore, highlights an ongoing methodological challenge: while recent studies have increasingly explored digital competence assessment and validation (Horváth et al., 2025; Kadluba et al., 2025), fewer studies have systematically investigated whether reported competence development corresponds with observable instructional behaviour.

ICT INTEGRATION IN THE UAE CONTEXT

The United Arab Emirates (UAE) has positioned digital transformation as a strategic national priority, embedding ICT integration within inspection frameworks and quality assurance processes

(KHDA, 2015). Schools across the UAE are typically well-resourced technologically, creating favourable infrastructural conditions for digital learning environments.

Despite these investments, empirical evidence suggests that ICT integration remains variable across classrooms, with many teachers employing technology primarily for presentation or administrative purposes rather than pedagogically transformative learning experiences (Tondeur et al., 2016). Variability in professional preparation, pedagogical training, and digital confidence contributes to uneven implementation and limits the outcomes associated with generic professional development initiatives.

The persistence of substitution-level ICT practices despite favourable infrastructural conditions underscores the need for practice-oriented evaluation models capable of examining instructional enactment rather than merely resource availability. In this context, frameworks that operationalise digital competence through observable classroom behaviours are particularly relevant.

Rationale for a Practice-Oriented Framework

The literature consistently identifies a gap between conceptual digital competence frameworks and their practical application in classrooms (Ertmer & Ottenbreit-Leftwich, 2010; Fullan, 2020). Teachers require frameworks that articulate competence in observable, actionable terms, while school leaders require evaluative tools that support monitoring, coaching, and strategic planning.

The Teacher Digital Competency Framework (TDCF) developed in this study directly addresses this methodological challenge by prioritising pedagogical application, staged progression, and contextual relevance. Grounded in classroom practice and aligned with leadership needs, the framework seeks to bridge the divide between policy aspirations and instructional reality.

Critically, this study advances digital competence research by reframing teacher digital competence from a predominantly knowledge-based construct to a practice-observable construct. While existing frameworks such as TPACK and DigCompEdu conceptualise digital competence in terms of knowledge domains, capacities, or proficiency descriptors, they offer limited methodological guidance on how such competence is enacted and evidenced in day-to-day classroom practice. The TDCF shifts the unit of analysis from competence possession to competence enactment, operationalising digital competence through staged, observable pedagogical behaviours embedded within instructional planning, classroom interaction, and assessment practices. This reframing responds directly to critiques regarding the abstraction of digital competence frameworks and establishes a clearer analytical bridge between teacher competence development, professional learning interventions, and observable instructional change.

While TPACK conceptualises digital competence as the intersection of technological, pedagogical, and content knowledge domains (Mishra & Koehler, 2006), and DigCompEdu structures competence across professional engagement, digital resources, pedagogy, assessment, and learner empowerment (Horváth et al., 2025; Redecker, 2017), both frameworks primarily articulate competence as a knowledge-based or descriptor-based construct (Horváth et al., 2025; Redecker, 2017). Their empirical evaluation has largely relied on perception-based survey instruments, which risk conflating reported capability with enacted instructional behaviour (Horváth et al., 2025; Kadluba et al., 2025; Siddiq et al., 2016).

By contrast, observational models shift attention to classroom-level enactment but often lack alignment with staged competence progression frameworks (Johannesen et al., 2014; Kimmons & Hall, 2018; Pareto & Willermark, 2018). The present study sits at the intersection of these traditions. It retains the conceptual grounding of TPACK and DigCompEdu while embedding competence within observable, staged pedagogical behaviours assessed through structured classroom observation (Mishra & Koehler, 2006; Redecker, 2017). Methodologically, it moves beyond survey-only evaluation by employing a convergent mixed-methods design to test whether self-reported competence progression corresponds to enacted classroom practice (Horváth et al., 2025; Kadluba et al., 2025). In

doing so, the study advances research on digital competence by integrating conceptual, perceptual, and observational lenses into a single evaluative framework.

Despite the extensive development of digital competence frameworks and self-report measures, questions remain about how teachers' digital competence is enacted in classroom practice and how perceived competence aligns with observable instructional behaviour. This study addresses this methodological challenge by employing a convergent mixed methods design that integrates self-reported competence data with structured classroom observations to examine both development and enactment.

METHODOLOGY

RESEARCH DESIGN

This study adopted a mixed-methods research design to develop and evaluate the Teacher Digital Competency Framework (TDCF) and to examine its patterns in teachers' ICT integration practices. A mixed-methods approach was selected to capture both measurable changes in competence and observable classroom practices, thereby supporting triangulation of findings (Creswell & Plano Clark, 2018).

Specifically, the study employed a convergent design, in which quantitative and qualitative data were collected within the same implementation phase and analysed to determine the degree of alignment between perceived and enacted competence (Creswell & Plano Clark, 2018). Data were collected from the same cohort of teachers prior to and following the professional development intervention, enabling within-subject pre–post comparison of capability levels alongside an investigation into the extent of observable enactment of digital competence in classroom practice.

The study may therefore be characterised as a descriptive within-subject pre–post quasi-experimental design embedded within a convergent mixed-methods framework. Quantitative data established baseline competence levels and post-intervention change, while documented classroom practice and teacher feedback provided insight into how these capabilities translated into pedagogical practice.

CONTEXT AND PARTICIPANTS

The study was conducted in nine private schools across three emirates in the United Arab Emirates: Abu Dhabi, Dubai, and Sharjah. These schools were selected to reflect variation in geographical location and institutional context across the emirates, ensuring representation across school settings and enabling a more comprehensive examination of how such competence develops in varied institutional contexts.

Participants included 150 teachers working in Cycle 2 and Cycle 3 classrooms. Cycle 2 and Cycle 3 refer to the upper primary and lower secondary stages within the UAE education system. Teachers represented a range of subject areas and professional experience levels. The UAE's diverse teaching workforce provided a relevant context for examining differentiated development of digital competence, as participants held varied qualifications and prior exposure to educational technology.

Participants were selected based on their active teaching roles in Cycle 2 and Cycle 3 classrooms and their full participation in the professional development intervention, ensuring alignment between instructional practice and exposure to the framework.

Participation was voluntary, ethical approval was obtained in accordance with institutional requirements, and informed consent was secured electronically. All data were anonymised to protect participant confidentiality.

A purposive, multi-stage sampling strategy was employed. The nine schools were selected based on two criteria: (1) an inspection rating of Acceptable or above as determined by the relevant educa-

tional inspection authority, ensuring that participating schools had established instructional and quality assurance processes capable of supporting TDCF implementation; and (2) geographical representation, with three schools selected from each of the three participating emirates: Abu Dhabi, Dubai, and Sharjah. Within participating schools, all eligible Cycle 2 and Cycle 3 teachers were invited to participate, and the resulting sample comprised 150 teachers distributed across the nine schools. This approach ensured representation across multiple educational contexts while maintaining a comparable baseline level of school quality. Classroom observations were conducted with a randomly selected subsample of 55 teachers, with a near-equal distribution across the three participating emirates to ensure geographical balance within the convergence analysis.

Development of the Teacher Digital Competency Framework (TDCF)

The Teacher Digital Competency Framework (TDCF) (Table 1) was developed through a review of existing international digital competence frameworks, including DigCompEdu, TPACK, and ISTE standards, alongside analysis of contextual challenges identified in UAE classrooms (Mishra & Koehler, 2006; Redecker, 2017).

Table 1. TDCF domains and conceptual influences

TDCF domain	Conceptual influence	Operationalised as observable behaviour
Student learning & creativity	TPACK (pedagogical-content alignment)	ICT use aligned to learning objectives and higher-order tasks
Digital pedagogy & assessment	DigCompEdu pedagogy & assessment domains	Technology integrated into formative assessment sequences
Learning environment	ISTE learning facilitator standards	Structured digital collaboration & engagement practices
Digital citizenship	DigCompEdu professional responsibility	Explicit modelling of ethical ICT use
Professional growth	DigCompEdu professional engagement	Reflective ICT adaptation & peer collaboration

While these frameworks informed the conceptual foundation of the TDCF, the framework was intentionally designed to prioritise classroom-level practice, visible teaching behaviours, and progressive competence development, thereby addressing limitations in operational clarity and classroom applicability identified in the literature (Fullan, 2020).

The framework articulated staged levels of digital competence (Awareness, Basic, Intermediate, Advanced, Expert), enabling teachers to self-assess their current practice and identify clear pathways for progression (Figure 1). Each level included practical descriptors aligned to instructional planning, classroom implementation, student engagement, and assessment practices involving ICT.

Data Collection Instruments

Multiple instruments were used to evaluate the implementation and outcomes associated with the TDCF.

Teacher digital competency survey

A self-administered survey aligned to the TDCF descriptors was used to assess teachers' perceived overall digital competence prior to and following the intervention. Teachers selected the competence stage that best represented their current level of ICT integration (Awareness, Basic, Intermediate, Advanced, Expert). This categorical self-assessment allowed for distributional comparison of competence shifts within the same participant cohort.

Teacher Digital Competency Framework

Teachers' Digital Competencies	Elements	Proficiency Level				
		Awareness	Basic	Intermediate	Advanced	Expert
1. Promote student learning and creativity Teacher integrates ICT with subject matter expertise and pedagogical practices to provide students with opportunities to advance in learning, critical thinking, and innovation. (1.3.2/ 2.2.1/ 2.2.2 /3.2.4)	1.1 Encourage creativity					
	1.2 Encourage the use of ICT to solve real life issues					
	1.3 Encourage student reflection					
	1.4 Engage in collaborative knowledge					
2. Implement Digital Pedagogical Experiences and Assessments Teacher incorporates ICT to introduce and assess authentic pedagogical experiences and assessments, giving students opportunity to develop their knowledge, abilities, and personal attitudes while considering digital tools and resources that empower learning content. (1.3.3/ 2.1.2/ 2.2.3/ 2.3.2/ 3.1.1/ 3.1.2/ 3.1.3/ 3.2.2/ 3.3.1/ 3.3.2)	2.1 Empower students with learning experiences					
	2.2 Encourage students to set goals and track progress					
	2.3 Differentiate and personalize learning					
	2.4 Assess ICT learning practices to improve pedagogy					
3. Promote a Digital Age Learning environment Teacher models professionalism by exchanging and integrating ICT-based knowledge, skills, and work processes in a e-society. (1.5.1/ 1.5.2/ 1.5.3/ 2.1.1/ 2.3.2/ 3.2.4/ 3.3.3)	3.1 Integrate and transfer knowledge with ICT					
	3.2 Communicate and collaborate with stakeholders to improve student achievement					
	3.3 Share, analyze, evaluate, and use information resources to support research and learning					
4. Model digital citizenship and responsibility Teacher demonstrates netiquette and models legal and safe behavior in evolving digital environments. (1.1.1/ 1.2.2/ 1.3.1/ 3.1.1)	4.1 Model the use of ICT safely and securely					
	4.2 Ensure equal ICT access and resources to all students					
	4.3 Model netiquette					
	4.4 Model responsibility and engage in cultural understanding					
5. Maintain professional growth and leadership Teachers develop their ICT professional practice and lead by example within and beyond the school environment. (1.2.3/1.5.3/ 2.3.1/ 3.2.4/ 4.1.1/ 4.1.2/ 4.1.3/ 4.2.2/ 4.3.1/4.3.2/ 4.1.4)	5.1 Explore ICT tools to improve student learning					
	5.2 Model and promote leadership with ICT skills reflected in decision making and community building					
	5.3 Maintain professional development practices that impact performance and the overall community					

NB: The 3-digit numbers under each component indicate a clear alignment of the TDCF with the Performance Standards for teachers and Educational Leadership in the UAE/ November 2015

Figure 1. Structure of the Teachers' Digital Competency Framework (TDCF)

Classroom observation rubric

Classroom practice was evaluated using a structured rubric derived from the TDCF domains and aligned with Bloom's Taxonomy (Anderson & Krathwohl, 2001). Unlike the self-assessment instrument, which contained eighteen discrete elements across five digital competence domains, the observation rubric operationalised enacted practice through three composite pedagogical indicators. Each indicator was rated on a four-point scale (1 = Needs Improvement, 2 = Emerging, 3 = Developing, 4 = Proficient). For each teacher, ratings across the three indicators were averaged to produce an overall enactment score representing the observed competence stage (Figure 2).

Rubric for Observing Teachers Integrating ICT

(Based on the Comprehensive Tables of each TDCF Element resulting from Marrying Bloom's Taxonomy and Blow's E-Word Framework)

	Needs Improvement	Emerging	Developing	Proficient
TDCF Digital Competency and associated. TDCF Element ICT Skills and associated. ICT Tools E-Word Framework	☐ The teacher poorly integrates ICT in line with the TDCF. The digital competency and selected element are poorly addressed. ☐ The skill and selected tool are at the **Basic** level of the TDCF. ☐ The evidence of student engagement and learning is at **Enrich** as per E-Word Framework.	☐ The teacher sometimes integrates ICT in line with the TDCF where the digital competency and selected element are occasionally addressed. ☐ The skill and selected tool are at the **Intermediate** level of the TDCF. ☐ The evidence of student engagement and learning is at **Enhance** as per E-Word Framework.	☐ The teacher integrates ICT in line with the TDCF where the digital competency and selected element are addressed. ☐ The skill and selected tool are at the **Advanced** level of the TDCF. ☐ The evidence of student engagement and learning is at **Extend** as per E-Word Framework.	☐ The teacher integrates ICT effectively in line with the TDCF where the digital competency and selected element are clearly addressed. ☐ The skill and selected tool are at the **Expert** level of the TDCF. ☐ The evidence of student engagement and learning is at **Empower** as per E-Word Framework.

Figure 2. Rubric for observing teachers' integration of ICT

The rubric was designed to capture pedagogical enactment at a holistic instructional level rather than replicate each of the eighteen self-assessment elements individually. This distinction reflects the methodological intention of examining competence enactment through visible instructional patterns rather than granular descriptor matching.

The rubric was piloted prior to implementation to ensure clarity, feasibility, and alignment with TDCF performance descriptors. All observations were conducted by a single trained observer to maintain scoring consistency.

Professional development evaluation and reflections

A professional development evaluation survey employing 5-point Likert-scale items was administered to assess session relevance, engagement, applicability, and overall satisfaction. In addition, qualitative feedback was collected to capture teachers' perceptions of framework usability, professional development, and changes in instructional confidence.

TDCF Self-Assessment Instrument

The Teacher Digital Competency Framework (TDCF) self-assessment tool was used to measure teachers' perceived digital competence across five domains: (1) promoting student learning and creativity, (2) implementing digital pedagogical experiences and assessments, (3) promoting a digital-age learning environment, (4) modelling digital citizenship and responsibility, and (5) maintaining professional growth and leadership. Each domain contained multiple elements aligned with the staged proficiency structure of the TDCF.

The self-assessment instrument comprised eighteen elements distributed across the five TDCF domains. Each domain contained between three and four items reflecting staged descriptors of pedagogical ICT integration. Teachers selected the stage descriptor that most closely represented their current instructional practice. The same instrument was administered pre- and post-intervention to enable paired comparison.

Teachers rated themselves against five developmental stages: Awareness, Basic, Intermediate, Advanced, and Expert. These stages reflected increasing levels of pedagogical integration and alignment with Bloom's Taxonomy (Anderson & Krathwohl, 2001). The instrument was administered before and after the professional development intervention, using the same structure to allow for paired comparisons. Stage selections were numerically coded (Awareness = 1, Basic = 2, Intermediate = 3, Advanced = 4, Expert = 5) to enable statistical analysis.

Content validity was established through expert review by two senior instructional leaders and one educational technology specialist, who examined alignment between staged descriptors and classroom-level pedagogical indicators. Minor wording refinements were made following this review to enhance clarity and eliminate descriptor overlap. Pilot administration with a small teacher subgroup (n = 17) confirmed interpretive clarity prior to full implementation.

Professional Development Intervention

Teachers participated in a structured four-day professional development programme explicitly aligned to the TDCF competence levels. Unlike generic ICT training, the sessions focused on how digital tools could support instructional goals, student engagement, and formative assessment, rather than on tool functionality alone. This approach reflects research advocating pedagogically grounded professional learning (Fullan, 2020).

Professional development activities included guided reflection, practical classroom application tasks, structured modelling of instructional strategies, and peer discussion, all of which were directly linked to lesson design and implementation. The intervention emphasised staged competence development and alignment between digital tool selection and pedagogical intention.

The programme was organised into four sequential phases focusing on: (1) conceptual understanding of digital competence as pedagogical enactment, (2) modelling of ICT-integrated instructional strategies, (3) guided lesson design and classroom application, and (4) reflective practice and peer feedback. Each phase explicitly aligned digital tool use with instructional objectives, student engagement, and formative assessment practices.

Data Collection Procedure

Data collection occurred in five structured phases. First, teachers completed the pre-intervention TDCF self-assessment to establish baseline perceived digital competence. Second, participants engaged in the targeted professional development programme aligned with the staged TDCF progression. Third, the same TDCF self-assessment instrument was re-administered post-intervention to measure perceived competence shifts. Fourth, structured classroom observations were conducted using the TDCF observation rubric. Finally, survey, observation, and performance data were integrated for triangulated analysis.

Data Analysis

Pre-intervention and post-intervention competence levels were analysed using descriptive statistics and stage progression analysis. Stage categories were numerically coded from 1 to 5 to enable calculation of mean competence levels and estimation of effect size. Observation rubric scores were averaged across the three pedagogical indicators. Alignment between self-reported competence and observed practice was operationalised by assigning each teacher a dominant stage score from the post-intervention self-assessment and a corresponding mean stage rating from the classroom observation rubric. The degree of alignment was defined as placement within the same stage or within one adjacent stage (± 1) across the two measures. Teachers whose observation rating differed by more than one stage from their self-reported level were classified as non-convergent. Paired-samples t-tests were conducted using individual pre- and post-intervention competence scores. Cohen's d for repeated measures was calculated to estimate the magnitude of change. Convergence rates were calculated as the percentage of teachers meeting the same or adjacent stage criterion.

Reliability and Validity

The investigation of alignment was ensured through direct mapping between TDCF domains, the self-assessment instrument, and the observation rubric. The use of identical staged descriptors across instruments strengthened construct uniformity. The observation rubric was piloted prior to implementation to refine clarity and scoring precision. A single trained observer conducted all classroom observations to maintain procedural consistency. The use of paired pre-post measurements and statistical comparisons enhanced internal validity, while triangulation between self-report and observed practice strengthened the overall measurement of the alignment between perception and practice. Because the self-assessment instrument functioned as a staged categorical framework rather than a multi-item psychometric scale, internal consistency reliability (e.g., Cronbach's alpha) was not calculated. Instead, construct consistency was ensured through direct alignment between TDCF descriptors, survey stages, and observation rubric indicators. To enhance observational credibility, rubric calibration was conducted prior to formal data collection using sample lesson scenarios to refine scoring anchors. Calibration involved iterative refinement of scoring criteria using sample lesson scenarios to ensure consistency in interpretation.

Although observations were conducted by a single trained observer, structured performance descriptors reduced subjective interpretation and enhanced rating consistency. While the use of a single trained observer ensured procedural consistency, it limits the ability to establish inter-rater reliability. This is acknowledged as a methodological limitation. To mitigate potential subjectivity, detailed rubric descriptors and calibration using sample scenarios were employed to standardise scoring. Future studies should incorporate multiple observers to strengthen reliability and reduce potential bias.

Ethical Considerations

Ethical approval was obtained prior to data collection. Participation was voluntary, informed consent was secured electronically, and anonymity was maintained throughout data collection and reporting. Data were stored securely and used solely for research purposes.

RESULTS

The results are presented in alignment with the study's research questions, examining (1) changes in self-reported digital competence, (2) documented classroom practice, and (3) the degree of alignment between perceived and enacted competence.

Quantitative Findings: Pre- and Post-TDCF Digital Competence

Quantitative analysis examined within-subject changes in teachers' self-reported digital competence following implementation of the Teacher Digital Competency Framework (TDCF) and associated professional development. Teachers selected the competence stage that best represented their overall level of ICT integration (Awareness, Basic, Intermediate, Advanced, Expert) before and after the intervention. A paired-samples t-test was used to examine pre–post differences in competence levels, with effect size calculated using Cohen's d.

Pre-intervention data indicated that the majority of teachers clustered at lower competence stages, with ICT use predominantly characterised by presentations, content delivery, and basic administrative functions. The largest proportions of participants were identified at the Awareness and Basic levels.

Post-intervention distributional analysis demonstrated a clear redistribution of teachers across competence stages. The proportion of teachers identifying at entry-level stages (Awareness and Basic) decreased, while corresponding increases were observed at Intermediate and Advanced stages. Movement toward higher competence stages reflects progression in teachers' perceived ability to integrate ICT in pedagogically purposeful ways.

Pre- and post-intervention competence levels were compared using descriptive stage progression analysis. Stage categories were coded numerically (1–5) to enable calculation of mean competence levels and estimation of effect size. Mean competence scores increased from $M = 1.85$, $SD = 0.83$ pre-intervention to $M = 3.19$, $SD = 0.93$ post-intervention, reflecting an average stage progression of 1.34 levels. This increase reflects a change in mean competence levels across stages. The magnitude of change was large (*Cohen's d* = 1.52). A paired-samples t-test indicated a statistically significant increase in self-reported digital competence from pre-intervention ($M = 1.85$, $SD = 0.83$) to post-intervention ($M = 3.19$, $SD = 0.93$), $t(149) = 18.62$, $p < .001$, Cohen's $d = 1.52$. The mean increase of 1.34 competence stages represents a large effect. Distributional analysis further demonstrated a marked shift from lower competence stages toward higher levels. Prior to the intervention, 80.0% of teachers were classified at the Awareness or Basic stages ($n = 120$), whereas following the intervention, this proportion decreased to 21.3% ($n = 32$). Conversely, the proportion of teachers classified at the Intermediate stage or above increased from 20.0% ($n = 30$) pre-intervention to 78.7% ($n = 118$) post-intervention.

Figure 3 presents the distribution of teachers across competence stages before and after implementation of the TDCF ($N = 150$). The figure illustrates a clear shift in distribution from lower competence stages (Awareness and Basic) toward higher stages (Intermediate and Advanced) following the intervention.

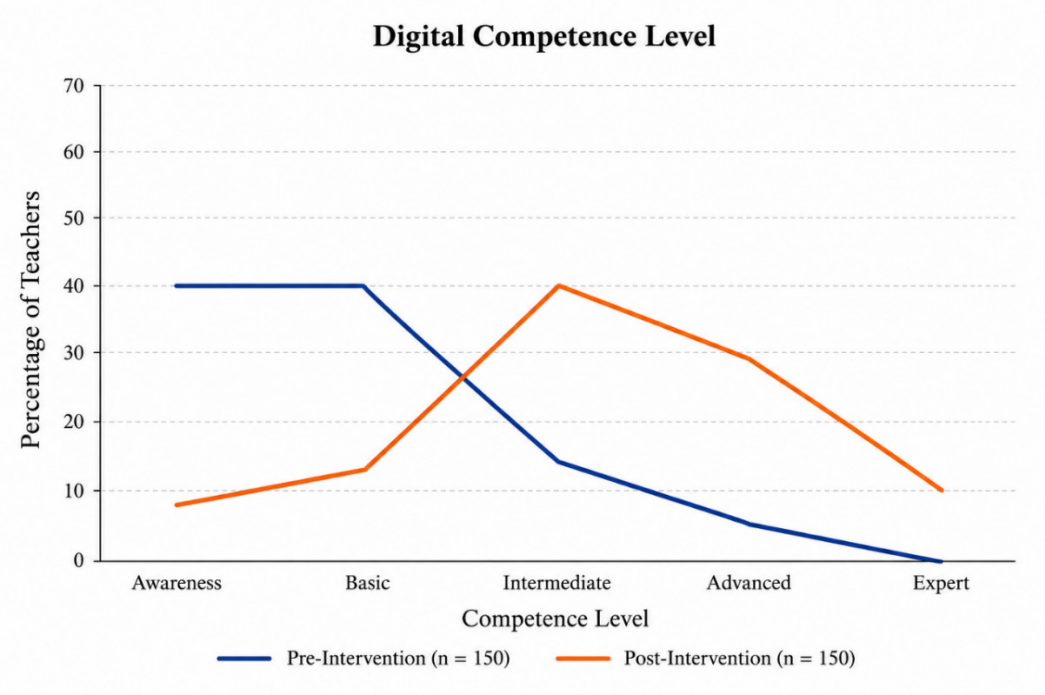

Figure 3. Distribution of teacher digital competence levels before and after TDCF implementation (N = 150)

Classroom Observation Evidence of ICT Integration

Classroom observations were conducted post-intervention with a randomly selected subsample of 55 teachers drawn from the participating cohort of 150, with a near-equal distribution across the three participating emirates. All observed teachers had completed the post-intervention TDCF self-assessment survey. Of the 55 observed lessons, 28 (51%) were rated as Proficient, 19 (35%) as Developing, and 8 (15%) as Emerging. No lessons were categorised as Needs Improvement. These findings indicate that the majority of documented classroom practice reflected pedagogically purposeful ICT integration (Table 2).

Table 2. Observed ICT integration practices categorized by TDCF competence levels

Category	Sharjah	Abu Dhabi	Dubai	Total
Number of Observations	20	18	17	55
Performance Levels				
Proficient (51%)	10	9	9	28
Developing (35%)	7	6	6	19
Emerging (15%)	3	3	2	8
Needs Improvement (0%)	0	0	0	0

Note. Counts represent the number of observed lessons within each performance category (N = 55).

Importantly, ICT use was embedded within instructional sequences to support student engagement, collaboration, and formative assessment rather than functioning primarily as a presentation tool. These documented patterns indicate movement beyond substitution-level integration as described in the literature (Ertmer & Ottenbreit-Leftwich, 2010).

Integrated Quantitative–Observational Summary

Integration of post-intervention survey and observation data was conducted at the individual teacher level for the 55 teachers who were both surveyed and observed. Each teacher's self-reported post-intervention competence stage was compared with their observed instructional performance as rated using the TDCF-aligned rubric.

Of the 55 teachers observed, 18 (32.7%) demonstrated exact convergence between their self-reported competence stage and observed enactment rating. A further 18 (32.7%) demonstrated adjacent-stage alignment (±1 stage difference). Nineteen (34.5%) were classified as non-convergent, with discrepancies exceeding one stage level. Overall, 36 of the 55 teachers (65.5%) met the predefined convergence criterion (same or adjacent stage), indicating substantial alignment between perceived competence and documented instructional practice.

Teachers self-identifying at higher competence stages were more likely to demonstrate Proficient or Developing levels during classroom observation, whereas those self-identifying at lower stages were more frequently categorised at the Emerging level. The quantified convergence strengthens interpretive validity by demonstrating that reported competence progression corresponded with observable instructional behaviour rather than reflecting perception alone (Creswell & Plano Clark, 2018).

Taken together, the findings indicate measurable shifts in perceived digital competence alongside visible enactment consistent with the framework's descriptors. The relationship between reported and enacted competence addresses longstanding concerns regarding the limited alignment between digital competence frameworks and classroom practice (Horváth et al., 2025; Kadluba et al., 2025).

Discussion

This study examined the development and evaluation of a Teacher Digital Competency Framework (TDCF) designed to support meaningful ICT integration in the classroom. The findings indicate that the framework, when implemented alongside targeted professional development, was associated with measurable shifts in teachers' self-reported digital competence and corresponding patterns in observed pedagogical practice. These findings respond directly to longstanding concerns in the literature regarding the historical disconnect between digital competence frameworks and observable classroom practice (Ertmer & Ottenbreit-Leftwich, 2010; Redecker, 2017).

Interpreting Digital Competence Growth

The observed redistribution of teachers across digital competence stages following implementation of the TDCF suggests progression that extends beyond isolated technical skill acquisition. Rather than reflecting increased tool familiarity alone, the findings indicate shifts in teachers' reported instructional decision-making regarding the pedagogical use of ICT. This distinction is critical, as meaningful ICT integration depends on teachers' ability to align digital tools with learning objectives, assessment practices, and student engagement strategies (Mishra & Koehler, 2006).

The movement away from entry-level competence stages toward intermediate and advanced stages is consistent with critiques of generic, tool-focused professional development models, which have been shown to produce limited instructional transformation (Ertmer & Ottenbreit-Leftwich, 2010). By contrast, the staged structure of the TDCF appears to have supported teachers in conceptualising digital competence as a progression of pedagogical practices, enabling clearer identification of current practice and next-step development.

Importantly, the degree of alignment between self-reported competence progression and post-intervention classroom observations strengthens confidence in this interpretation. Because observation ratings were aligned to the same competence descriptors, the alignment between perceived stage and enacted instructional behaviour suggests that reported shifts were reflected in practice rather than re-

maining at the level of perception. Mixed-methods research emphasises that such convergence enhances interpretive validity by reducing reliance on self-report data alone (Creswell & Plano Clark, 2018).

Taken together, these findings suggest that practice-oriented competence frameworks, when aligned with structured professional development, can support measurable shifts in how ICT is pedagogically enacted within classrooms. An important finding was the substantial degree of alignment between self-reported competence and documented classroom practice. Given prior research highlighting discrepancies between perceived and enacted competence, the level of alignment observed in this study suggests that structured, practice-oriented frameworks may reduce this divergence more effectively than previously assumed.

From Competence Possession to Competence Enactment

A persistent limitation in digital competence research is the treatment of competence as a possession – a set of knowledge domains or proficiencies assumed to reside within teachers – rather than as something enacted through instructional practice. Established frameworks such as TPACK and DigCompEdu provide strong conceptual foundations but remain comparatively abstract in relation to classroom enactment (Mishra & Koehler, 2006; Redecker, 2017). As a result, they often function as reflective or aspirational tools rather than operational instruments for analysing instructional change.

The findings of this study suggest that reframing digital competence as a practice-observable construct offers a more analytically productive approach. By shifting the unit of analysis from competence possession to competence enactment, the TDCF enabled digital competence to be examined through observable instructional behaviours embedded within lesson planning, classroom interaction, and assessment processes.

Post-intervention classroom observations indicated that ICT was increasingly embedded within instructional sequences to support collaboration, formative assessment, and student engagement rather than functioning primarily as a presentation tool. While observational data were collected only following implementation of the framework, the alignment between observed practice and self-reported progression suggests that operational clarity within the framework may have supported pedagogical enactment.

By anchoring competence descriptors in observable behaviour, the TDCF addresses a longstanding analytical gap between conceptual frameworks and classroom-level evidence. This study, therefore, contributes to the digital competence literature by demonstrating how abstract competence constructs can be operationalised in ways that permit empirical examination of reported and enacted competence, rather than solely perception. This reframing also shifts digital competence evaluation from static capability measurement to dynamic instructional pattern analysis, aligning competence assessment with the authentic complexity of classroom practice.

However, alternative explanations should be considered. It is possible that the observed instructional patterns were shaped not only by the framework itself but also by increased teacher awareness resulting from participation in the study or observation process. Additionally, contextual factors such as school leadership support or existing digital infrastructure may have contributed to the observed outcomes.

Leadership and Professional Development Implications

The findings also highlight the central role of leadership in enabling coherent, practice-oriented digital competence development. Educational change research consistently emphasises that sustained instructional improvement depends on alignment among professional learning, classroom practice, and accountability structures rather than isolated training initiatives (Fullan, 2020).

The TDCF served as a shared reference framework that supported such alignment by linking competence descriptors directly to observable instructional behaviours. Unlike generic ICT professional development programmes that emphasise tool functionality, the TDCF provided leaders with a structured means of differentiating professional learning according to teachers' current competence stages.

Distributed leadership research suggests that improvement efforts are more likely to be sustained when responsibility for instructional development is supported through shared language and common evaluative criteria (Spillane, 2006). In this study, the TDCF appeared to facilitate professional dialogue among teachers, instructional coaches, and school leaders by providing a concrete basis for observation, feedback, and coaching.

Within inspection-driven education systems such as the UAE, where leaders are required to evidence effective ICT integration, the framework also served as a monitoring instrument that distinguished between superficial technology use and pedagogically meaningful integration. By foregrounding observable teaching behaviours rather than tool adoption, the TDCF supported more informed professional judgement and reduced reliance on compliance-driven indicators.

Taken together, these findings suggest that digital competence frameworks designed around observable enactment may serve not only as teacher development tools but also as strategic leadership instruments that support coherence between professional development, instructional monitoring, and school improvement priorities.

These interpretations should be considered in light of methodological limitations, including the use of a single observer and the absence of pre-intervention classroom observations. While triangulation strengthens interpretive validity, these factors may limit the extent to which causal relationships can be inferred.

From a practical perspective, the findings provide school leaders with a structured mechanism for diagnosing, monitoring, and supporting the development of teachers' digital competence. By aligning observable classroom practices with staged competence descriptors, leaders can use the framework to differentiate professional development, guide instructional coaching, and evaluate outcomes of ICT integration initiatives. Within the UAE context, where accountability systems emphasise evidence of effective teaching and learning, such a framework offers a practical tool for moving beyond compliance-based monitoring toward evidence-informed instructional improvement.

CONTRIBUTION OF THE STUDY

This study makes three interrelated contributions to educational technology research and practice. First, it contributes empirically by demonstrating that a practice-oriented digital competence framework structured around staged pedagogical behaviours is associated with measurable shifts in teachers' instructional use of ICT. In addition, the study contributes methodologically by advancing a replicable evaluation approach that aligns self-reported digital competence measures with structured classroom observation data. This correspondence enables examination of whether reported competence progression is reflected in classroom enactment. The findings provide descriptive evidence that competence development framed as pedagogical progression, rather than technical skill acquisition, can support movement beyond substitution-level technology use toward more purposeful integration aligned with learning objectives, student engagement, and formative assessment (Ertmer & Ottenbreit-Leftwich, 2010; Mishra & Koehler, 2006).

Second, the study contributes conceptually by operationalising digital competence frameworks in ways that respond to critiques regarding limited classroom usability. While models such as TPACK and DigCompEdu provide robust theoretical foundations, they often lack explicit indicators that support systematic analysis of observable practice (Mishra & Koehler, 2006; Redecker, 2017). By translating competence descriptors into staged, practice-observable instructional behaviours, this

study demonstrates how abstract constructs can be rendered analytically actionable at the classroom level, addressing a persistent limitation in connecting theoretical frameworks to classroom enactment.

Third, the study contributes at the leadership and system levels by illustrating how digital competence frameworks can serve as strategic instruments for professional development, instructional monitoring, and coaching. The alignment of competence descriptors, classroom observation, and targeted professional learning supported greater coherence between instructional expectations and professional development practices. This finding aligns with research emphasising the importance of coherence and shared instructional language in sustaining educational change (Fullan, 2020).

Although situated within the UAE context, the staged design logic and enactment-focused orientation of the Teacher Digital Competency Framework offer transferable analytical insights for systems seeking to strengthen alignment between digital competence policy, professional development, and classroom practice.

CONCLUSION AND IMPLICATIONS

This study examined the development and implementation of a Teacher Digital Competency Framework (TDCF) designed to address the historical disconnect between conceptual digital competence models and observable classroom practice. The findings indicate that when digital competence is operationalised through staged, visible pedagogical behaviours and aligned with targeted professional development, teachers demonstrate measurable progression in self-reported competence alongside corresponding patterns in enacted instructional practice.

Quantitative findings revealed a statistically significant increase in self-reported digital competence ($M = 1.85$, $SD = 0.83$ to $M = 3.19$, $SD = 0.93$; $t(149) = 18.62$, $p < .001$, Cohen's $d = 1.52$), with the proportion of teachers at Intermediate stage or above rising from 20.0% to 78.7%, with substantial alignment (65.5%) between perceived and documented instructional practices.

These findings should be interpreted within clearly defined boundary conditions. The TDCF was implemented and evaluated in well-resourced private school contexts in the United Arab Emirates that operated under inspection-driven accountability structures. The observed progression patterns, therefore, reflect conditions in which structured professional learning and instructional monitoring were institutionally supported. While the enactment-focused design may hold relevance beyond this context, its transferability requires further empirical examination across varied governance, resource, and policy environments.

This study makes three key contributions. Conceptually, it reframes teacher digital competence as an enacted pedagogical construct grounded in visible classroom behaviour. Methodologically, it advances a convergent mixed-methods approach that analyses the degree of alignment between self-reported competence measures and structured classroom observation data. Practically, it provides a structured framework that supports professional development, instructional monitoring, and leadership decision-making. By anchoring evaluation in observable practice, the framework offers school leaders a robust mechanism for supporting ICT integration.

Taken together, these findings provide empirical evidence that aligning digital competence frameworks with visible instructional practice can support pedagogical practices consistent with the framework descriptors. This strengthens the relationship between digital policy, professional learning, and classroom enactment, offering a more robust basis for evaluating technology integration in education systems.

IMPLICATIONS FOR PRACTICE

A central implication is that the development of digital competence may be more effectively framed as pedagogical progression rather than as technical skill acquisition. Frameworks that articulate visible

classroom indicators can support teachers in making informed instructional decisions and identifying feasible next steps in practice.

For school leaders, practice-observable competence frameworks may serve as operational tools for instructional monitoring, coaching, and the design of professional development. By providing shared language and observable reference points, such frameworks can support instructional coherence between professional learning, classroom practice, and accountability expectations.

At the policy level, high-level digital strategies may benefit from complementary teacher-facing instruments that translate strategic goals into documented classroom practice. The findings suggest that strengthening the alignment between policy expectations and enacted instructional behaviour may enhance the practical outcomes of national digital education initiatives.

Limitations and Future Research

Several methodological limitations should be acknowledged. First, while triangulation strengthened interpretive validity, elements of the analysis relied on self-reported measures of competence. Second, classroom observations were conducted post-intervention and did not include a pre-intervention observational comparison. Although a paired-samples t-test was conducted to examine pre–post change, more advanced modelling techniques were not employed. Finally, observations were conducted by a single researcher, limiting the assessment of inter-rater reliability.

Future research may examine longitudinal sustainability of competence enactment, comparative implementation across public and private sectors, and the mediating role of leadership practices in scaling enactment-oriented digital competence frameworks. Further studies employing inferential analysis or multi-rater observational designs could strengthen the evidentiary base for practice-oriented digital competence models. Because classroom observations were conducted only post-intervention, causal attribution should be interpreted cautiously.

Data Availability Statement

The datasets generated and analysed during the current study are not publicly available due to confidentiality and ethical restrictions but may be made available from the author upon reasonable request.

Conflict of Interest

The author declares no conflict of interest.

Use of AI

During the preparation of this work, the author used **ChatGPT (OpenAI)** to support language refinement, structural clarity, and editorial review of the manuscript. The author reviewed, edited, and verified all content generated with the assistance of this tool and takes full responsibility for the integrity, accuracy, and originality of the published work.

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AUTHOR

Dr. Nidal Abounajem, EdD, is a Programme Leader and Senior Leadership Master Trainer at Sharjah Education Academy in the United Arab Emirates, where he designs and delivers professional learning programmes in educational leadership, teaching and learning, quality assurance, and school improvement. He has more than 20 years of experience in K–12 and higher education, including teaching, instructional leadership, educational consultancy, and professional development.

His research interests include teacher digital competence, educational leadership, digital pedagogy, school improvement, quality assurance, and evidence-informed professional learning. His doctoral research developed the Teacher Digital Competency Framework (TDCF), designed to support and evaluate teachers' digital competence by integrating self-report and classroom observation evidence. He continues to conduct research and develop leadership and professional learning programmes that support educational transformation across the UAE and the wider region.